A COMPARISON OF SOURCES AND FORMS OF NITROGEN AND DATES OF APPLICATION FOR WHEAT

By

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Bachelor of Science

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1958

Submitted to the faculty of the Graduate College of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1966

A COMPARISON OF SOURCES AND FORMS OF NITROGEN

AND DATES OF APPLICATION FOR WHEAT

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ACKNOWLEDGEMENTS

The author wishes to express his appreciation to the Agronomy Department and to the Oklahoma Agricultural Experiment Station for making this study possible.

Special recognition and appreciation is due to Dr. B. B. Tucker, Chairman of the Graduate Committee, for guidance, patience, and encouragement during this study and to Dr. L. W. Reed and Dr. H. L. Young, Jr. for their invaluable assistance in this work.

Deepest appreciation is extended to my wife Connie and to my children, Mark, Tim, and Scott for their encouragement, understanding, and spirit of sacrifice during this study.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
II.	LITERATURE REVIEW	3
	Experimental Procedures	6
III.	RESULTS	9
	Wheat Grain Yield	9
	Nitrogen Content of Grain	13
	Yield of Nitrogen	15
	Straw Yield	19
IV.	CONCLUSIONS	23
V.	SUMMARY	25
LITERATURE CITED		26
APPENDIX		28

LIST OF TABLES

Table		Page
I.	Some Physical and Chemical Characteristics of Grant Silt Loam on the Wheatland Conservation Experiment Station, Cherokee, Oklahoma	7
II.	The Influence of Sources, Methods and Dates of Application of Nitrogen Fertilizers on the Nitrogen Content of Kaw Wheat Grain, Cherokee, Oklahoma	14
	APPENDIX	
I.	The Yield of Grain Following Application of Two Sources and Two Forms of Nitrogen Fertilizer Applied at Three Different Dates at Cherokee, Oklahoma, for the Crop Years 1960 Through 1964	30
II.	A Comparison of Ammonium Nitrate and Urea Sources of Nitrogen for Wheat Grain Yield at Cherokee, Oklahoma	31
III.	A Comparison of Forms of Nitrogen Fertilizer for Wheat Grain Yield at Cherokee, Oklahoma	31
IV.	A Comparison of Dates of Nitrogen Application for Wheat Grain Yield at Cherokee, Oklahoma	32
V.	Analysis of Variance of Wheat Grain Yields by Years	33
VI.	Analysis of Variance of Wheat Grain Yield Data Pooled for Years 1960 - 1963	34
VII.	Meterological Data From July 1, 1959, Through June 30, 1960, at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma	35
VIII.	Meterological Data From July 1, 1960, Through June 30, 1961, at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma	36
IX.	Meterological Data From July 1, 1961 Through June 30, 1962, at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma	37

Table Page

X. Meterological Data From July 1, 1962, Through June 30, 1963, at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma 38

XI. Meterological Data From July 1, 1963, Through June 30, 1964, at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma 39

XII. The Yield of Nitrogen Following Application of Two Sources and Two Forms of Nitrogen Fertilizer Applied at Three Different Dates at Cherokee, Oklahoma, for the Crop Years 1960 Through 1963. 40

XIII. A Comparison of Ammonium Nitrate and Urea Sources of Nitrogen for Pounds Nitrogen Removed Per Acre at Cherokee, Oklahoma 41

XIV. A Comparison of Forms of Nitrogen Fertilizer for Pounds Nitrogen Removed Per Acre at Cherokee, Oklahoma. 41

XV. A Comparison of Dates of Nitrogen Application for Pounds Nitrogen Removed Per Acre at Cherokee, Oklahoma. 42

XVI. The Yield of Straw Following Application of Two Sources and Two Forms of Nitrogen Fertilizer Applied at Three Different Dates at Cherokee, Oklahoma, for the Crop Years 1961 Through 1963. 43

XVII. A Comparison of Ammonium Nitrate and Urea Sources of Nitrogen for Wheat Straw Yield at Cherokee, Oklahoma . . 44

XVIII. A Comparison of Forms of Nitrogen Fertilizer for Wheat Straw Yield at Cherokee, Oklahoma. 44

XIX. A Comparison of Dates of Nitrogen Application for Wheat Straw Yield at Cherokee, Oklahoma. 44

XX. Analysis of Variance of Nitrogen Yield Data by Years . . . 45

XXI. Analysis of Variance of Nitrogen Yield Data Pooled for Years 1960 - 1963. 46

XXII. Analysis of Variance of Wheat Straw Yield by Years 47

XXIII. Analysis of Variance of Wheat Straw Yield Data Pooled for Years 1961 - 1963. 48

LIST OF FIGURES

Figure		Page
1.	A Comparison of the Yield of Kaw Wheat Fertilized With Ammonium Nitrate and Urea, Cherokee, Oklahoma	10
2.	A Comparison of the Yield of Wheat Fertilized With Liquid and Solid Forms of Nitrogen, Cherokee, Oklahoma	11
3.	A Comparison of the Yield of Wheat Fertilized With Nitrogen at Three Different Dates During Each Crop Year, Cherokee, Oklahoma.	12
4.	Yield of Nitrogen in Pounds Per Acre as Influenced by Source of Nitrogen	16
5.	Yield of Nitrogen in Pounds Per Acre as Influenced by Form of Nitrogen Application.	17
6.	Yield of Nitrogen in Pounds Per Acre as Influenced by Time of Application.	18
7.	Yield of Wheat Straw as Influenced by Source of Nitrogen. .	20
8.	Wheat Straw Yield in Pounds Per Acre as Influenced by Form of Nitrogen Application	21
9.	Wheat Straw Yield in Pounds Per Acre as Influenced by Dates of Application.	22

CHAPTER I

INTRODUCTION

The use of the stubble mulch system of tillage for wheat in Oklahoma has increased in recent years as a means of reducing wind and water erosion and for moisture conservation. The accumulation of straw residue at or near the soil surface presents other problems, however, one of which is the reduced rate of straw decomposition. This problem is intensified by the relatively short period for straw decomposition between harvest and planting of the new crop in a continuous wheat cropping system. One of the first manifestations of the problem is in the utilization of nitrogen. Much of the available nitrogen may be tied up in the process of straw decomposition for prolonged periods. Any additional available or applied nitrogen is ordinarily utilized by the plant in grain yield at the expense of the protein content of the grain.

Nitrogenous fertilizers are usually applied either at planting time in the fall or as a side dressing in the spring when clean tillage methods are used. An application of nitrogen immediately after harvest might be beneficial in the decomposition of straw where stubble mulch tillage is used, and thereby release more available nitrogen to the succeeding crop for increased yield and grain protein content. One purpose of the study reported here was to compare the effect of post-harvest, fall, and spring applications of nitrogen on yield and grain protein.

Acreage restrictions on wheat and the depletion of natural levels of nitrogen in the major soil types found in the wheat growing area have led to the increased use of nitrogenous fertilizers. In fact, the use of nitrogen fertilizers has more than doubled in the last ten years. New sources or forms of nitrogen fertilizers have become available and new methods of application have been devised. Therefore, this study also included two sources of nitrogen, ammonium nitrate and urea, and two methods of application, top dressing with a solid granular material and spraying with a liquid material.

CHAPTER II

LITERATURE REVIEW

There have been several studies on the relative efficiency of fall versus spring applications of nitrogen. Some of the earlier work was done by Eck (7) who attempted to raise the protein content of wheat by a late spring application of ammonium nitrate. Pope (13), in a study with five sources of nitrogen applied pre-plant and as a top dressing on winter wheat, found no significant difference in yield among plots receiving different sources of nitrogen or among plots receiving nitrogen at different dates. Pearson, et. al., (12) studied the residual effect of fall and spring applied nitrogen fertilizers over a period of three years at six locations in the southeastern United States. They reported that nitrogen broadcast in November or December was only 49 percent as effective as nitrogen applied the following spring. Roth, et. al., (14) showed that ammonium nitrate and urea nitrogen applied in the spring of the year resulted in higher wheat yields than December applied nitrogen. Smith (20), however, found no significant difference due to source of nitrogen or to time of application. He (19) conducted a series of studies to determine the effect of straw management and fertilizer practices on yields of wheat. Where ammonium nitrate and urea were compared there was no significant difference in yield due to nitrogen source. He did not mention any influences of nitrogen source or time of application on straw decomposition. However, Jackson, et. al., (9) in Oregon, showed that nitrate sources when applied to soils to which crop residue was added were not as efficient as ammonia sources. No other reports of nitrogen application to assist in straw or other crop residue decomposition have been found.

There have been a number of recent investigations concerning sources of nitrogen and the influence of nitrogen source on protein content and yield of wheat. Many of these studies have also been concerned with the loss of nitrogen through leaching or volatilization with different sources of nitrogen and different methods of application.

Volk (22), concluded that urea volatilized rapidly from most soils and that it should not be surface applied to sods or light sandy soils when they were in a moist condition. He found that urea should be "watered in" or covered by tillage if at all practical. In a further study he (23) pointed out that there are three important factors which influence urea loss by volatilization; temperature, moisture, and soil pH. He found high temperatures, high moisture levels and high soil pH all decreased the ammonia absorption potential of the soil and thus increased volatilization. Ernst and Massey (8), supported Volk and concluded by saying that urea topdressed on a moist soil under conditions of high temperature and/or high soil pH would be susceptible to sizeable losses of ammonia through volatilization. Blue, et. al. (3), in a study dealing with nitrogen solutions also pointed out that applications of urea usually resulted in low yields and low nitrogen recovery on nonlimed soils. Stangel (21), pointed out that urea, ammonium nitrate and ammonium sulfate all lost ammonia by volatilization when surface applied to soils with a pH of 7.5 or above. However, under water-logged conditions, nitrogen was lost to the atmosphere following applications of ammonium nitrate but not following applications of urea (10).

MacGregor (10), found no difference in oat or corn yields due to different nitrogen compounds. He found only a 6 percent nitrogen loss over a two-week period on a sandy loam soil with surface application of urea and 4 percent where the urea was covered with half an inch of soil. He pointed out that the plant recovers anywhere from 25 to 75 percent of the applied nitrogen, so that he did not consider a 6 percent loss to be of practical importance.

Olson (11), listed three "rules of thumb" for the prevention of nitrogen loss from any chemical form of fertilizer. These rules are: (1) use an ammonium salt, urea, or ammonia where leaching or water-logged conditions are expected after treatment; (2) place ammonia deep in moist soil and do not apply it on dry or very sandy soils with low ammonia absorbing capacity; (3) mix any urea compounds with the soil--not broadcast on the surface without mixing, whether in solution or in solid form.

So far as yield itself was concerned, Jackson, et. al. (9), in comprehensive field experiments found no significant difference between different forms of nitrogen if they were properly applied. Smith (17), likewise reported no significant differences in yield due to nitrogen carriers. Blue, et. al. (4), compared solid forms of urea and ammonium nitrate with Uran and Feran. They obtained no significant differences in yield or in nitrogen recovery by plants from different nitrogen sources. Results from an experiment conducted in Germany, (1), showed that when urea was applied as a spray in place of normal top dressing the yield response per unit nitrogen was about the same as with other nitrogen sources. However, Smith and Simpkins (18), made soil applications of urea and ammonium nitrate and obtained higher yields of wheat than with spray applications of the same materials.

Experimental Procedures

The investigation was located at the Wheatland Conservation Experiment Station, Cherokee, Oklahoma. The experiments were started in the summer of 1959 following crop harvest and continued through 5 crop years. The area involved was on a 1 percent slope on land which had been continuously cropped to wheat for over 40 years. For the 5 year study the seedbed was prepared by the use of stubble mulch tillage.

The soil of the area is a Grant silt loam which developed from deeply weathered calcareous shales and sandstones of the Red Beds. Before the experiments were started, representative soil samples were taken from the 0 to 12 inch layer (designated the "soil surface" in this study) and from the 12 to the 24 inch layer (designated the "subsurface"). The proportion of the various soil separates was determined by the hydrometer method (5), soil reaction was measured by the glass electrode method (15), and the organic matter determination was made by a method proposed by Schollenberger (16). Total nitrogen was obtained by use of the Kjeldahl technique (2), available phosphorous was measured by a method suggested by Bray and Kurtz (6), and cation exchange capacity determinations were made by the A.O.A.C. method (2). The results of these physical and chemical analyses of the soil are gien in Table I.

TABLE I

SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF GRANT SILT LOAM ON THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Depth in Inches	Percentages of Sand	Percentages of Silt	Percentages of Clay	pH	Percent O.M.	Percent Total N	Avail. P (lb/A)	Avail. K (lb/A)	C.E.C. Me/100 gms.
0-12	37%	50%	13%	5.80	1.33	.0143	175	600	9.32
12-24	37%	46%	17%	7.35	0.93	.0485	48	360	14.98

There were two sources of nitrogen used in the study; ammonium nitrate (33 percent N), and urea (45 percent N). Each of these sources were applied as a solid in granular form with a conventional grain drill, and as a liquid with a tractor mounted boom sprayer. Each material was applied at the rate of 40 pounds of actual N per acre. Each source and form of nitrogen used was applied at three dates; in the summer following harvest but prior to the initial tillage operation (approximately June 15), in the fall just after seedling emergence (approximately November 1) and in the spring prior to the initiation of spring growth (approximately March 1). There were, therefore, 12 treatments. Plots 12 feet by 75 feet in size were used in 4 replications with a randomized block design.

Phosphate fertilizer was applied as a blanket application over the entire experimental area in the fall of each year at planting time at the rate of 20 pounds of actual P_2O_5 per acre. Kaw wheat was used throughout the study and was planted at the rate of 40 pounds per acre.

An area 10 feet by 50 feet was harvested from each plot with a combine. Care was used to avoid harvesting the edge of the plot to avoid "border effects." The grain from each harvested plot was weighed and yields were calculated on an acre basis. Straw yields of each plot were determined from each harvested plot by cutting three random samples two rod rows in length. Grain samples from the random rod row samples were taken for determinations of nitrogen content. These determinations also were made with the Kjeldahl technique (2). The figures for total nitrogen yield were calculated from the total grain yield and the percent of nitrogen in the grain.

CHAPTER III

RESULTS

Wheat Grain Yield

The grain yield data for the entire experiment is listed in Appendix Table I. A comparison of yields with different sources of nitrogen (ammonium nitrate and urea) is given in Appendix Table II, and illustrated in Figure 1. No appreciable difference in yield between these two sources of nitrogen was evident and statistical analysis of the data (Appendix Tables V and VI) indicated there was no significant difference in these yields.

When the grain yield of plots receiving the solid nitrogen were compared with those receiving the liquid material (Appendix Table III and Figure 2) it was noted that in all cases the yields were higher with the solid form. Analysis of the data (Appendix Tables V and VI) indicated these differences between methods of application were statistically significant each of the four years, and for the data pooled by years. The largest yield difference was 2.2 bushels per acre, or approximately 8 percent of the average yield in these plots. Other factors being equal, a difference of this magnitude should be worthy of serious consideration.

The influence of the date of nitrogen application upon wheat grain yield is illustrated in Figure 3 (Appendix Table IV). Little difference

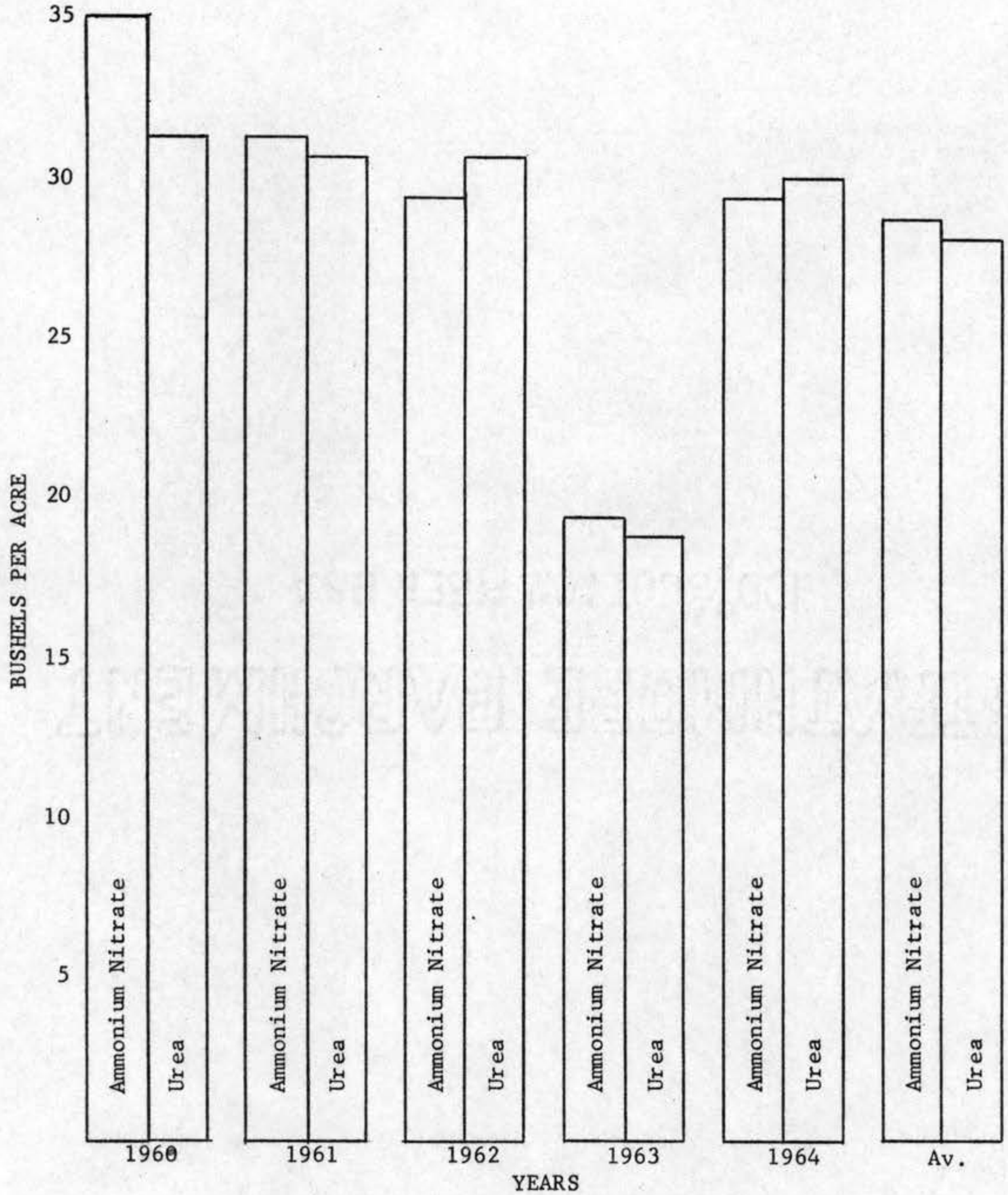

Figure 1. A Comparison of the Yield of Kaw Wheat Fertilized With Ammonium Nitrate and Urea, Cherokee, Oklahoma

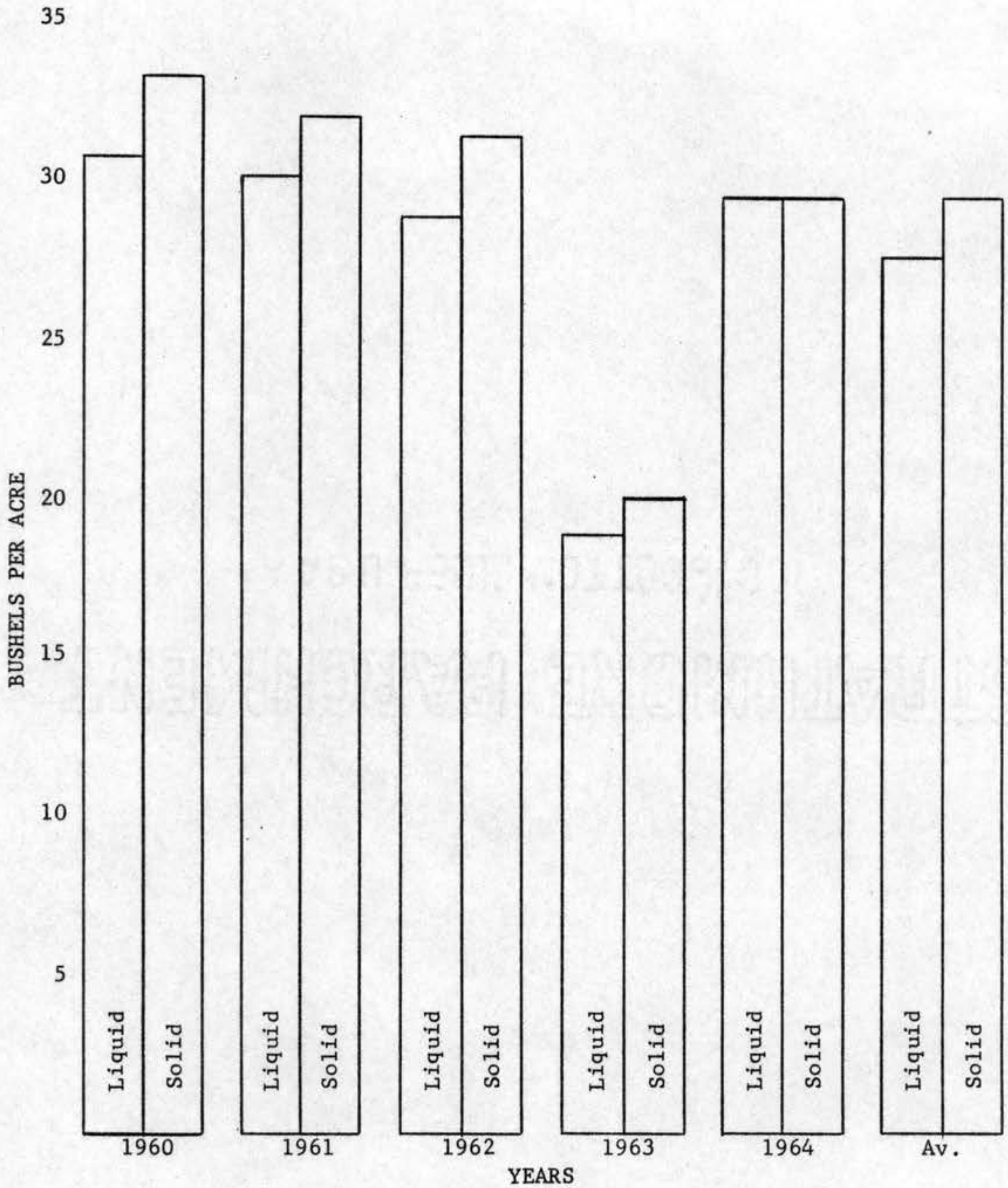

Figure 2. A Comparison of the Yield of Wheat Fertilized With Liquid and Solid Forms of Nitrogen, Cherokee, Oklahoma

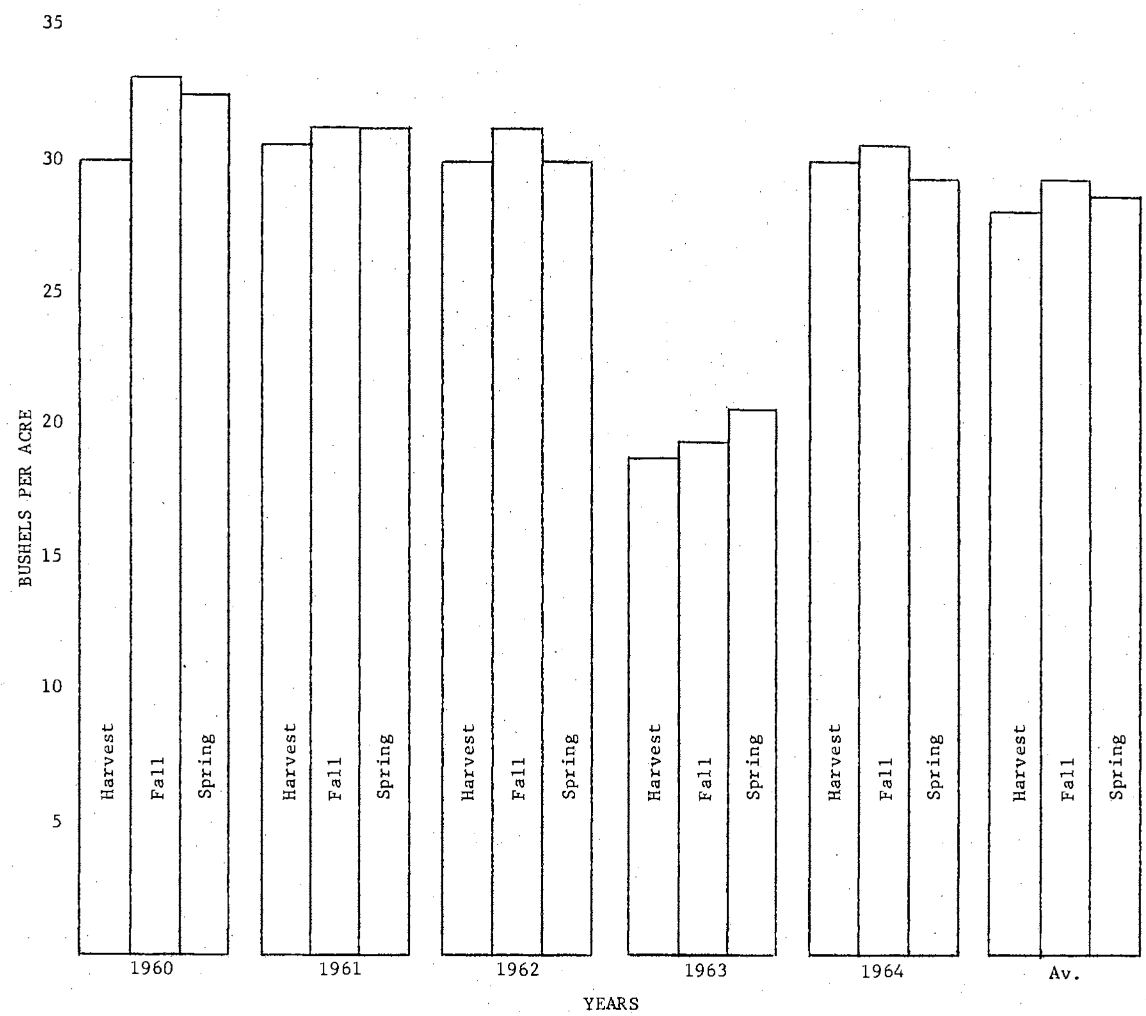

Figure 3. A Comparison of the Yield of Wheat Fertilized With Nitrogen at Three Different Dates During Each Crop Year, Cherokee, Oklahoma

in yield as a result of different dates of nitrogen application can be noted, although there was a consistent advantage to the fall application with the exception of 1963 when moisture was deficient. The advantage of fall application over either spring or summer application was statistically significant in only one year, 1961, (Appendix Table V), but when the data for all years were pooled, the observed differences were significant at least to the 5 percent level (Appendix Table VI).

The complete statistical analysis of the yield data for all years (Appendix Table VI) indicated a significant (5 percent level) difference involving the interaction between years, sources of nitrogen and dates of application, and involving the interaction of years and replications. However, the actual differences in yield were small, and probably reflect the influence of environmental factors in different years (Appendix Tables VII, VIII, IX, X, and XI).

Nitrogen Content of Grain

The mean percent of nitrogen content of the grain for each treatment for each year is presented in Table II. In all cases, the nitrogen content of grain from plots treated with urea was higher than when ammonium nitrate was used. However, the differences are quite small, particularly when compared to the differences between years, and it is doubtful if such differences have any practical significance. Similarly, in most cases higher nitrogen content was observed following spring applications of fertilizer, which supported earlier studies. In this study, however, the differences were quite small. Differences in nitrogen content of grain between plots receiving liquid and solid forms of nitrogen were small and inconsistent from year to year.

TABLE II

THE INFLUENCE OF SOURCES, METHODS AND DATES OF APPLICATION OF NITROGEN FERTILIZERS ON THE NITROGEN CONTENT OF KAW WHEAT GRAIN, CHEROKEE, OKLAHOMA

Treatment	Percent of Actual N in Grain Samples					
	1960	1961	1962	1963	1964	Average
NH_4NO_3	16.71	22.63	23.59	26.08	24.50	22.34
Urea	17.21	23.22	24.32	26.39	25.16	22.99
Spray	17.12	22.98	23.93	25.80	21.89	22.03
Solid	16.79	22.88	23.98	26.62	22.65	22.22
Harvest	16.17	21.67	22.81	25.84	20.17	20.98
Fall	17.01	23.99	25.10	25.97	22.30	22.55
Spring	17.62	23.09	23.94	26.83	23.59	22.65
Average	16.95	22.92	23.95	26.22	22.89	22.25

Yield of Nitrogen

Source of nitrogen had no practical effect upon the total yield of nitrogen (Figure 4 and Appendix Table XIII). Analysis of the data, (Appendix Table XX), showed a significant difference only in 1963, when poor crop yields were recorded due to deficient rainfall during the growing season. The 1964 yields indicated that the nitrogen had not been fully utilized from the 1963 crop and the effect was carried over into the following year. When the data were pooled for years, analysis showed that the source of nitrogen produced no significant difference in total yield of nitrogen (Appendix Table XXI).

The forms of nitrogen used influenced the total yield of nitrogen each year (Figure 5 and Appendix Table XIV). This was due, however, to the pronounced effect of the form of nitrogen on grain yield. The advantage of solid over liquid source amounted to a little over two pounds of total nitrogen per year, or roughly 5 percent of the total nitrogen yields.

The total yield of nitrogen was lowest when nitrogenous fertilizers were applied just after harvest (Figure 6 and Appendix Table XV). Analysis of the data for total nitrogen yields (Appendix Table XX) showed that there was a significant difference due to time of application every year. When yields of total nitrogen were compared with the climatological data, it was noted that the accumulated rainfall during the application period plays an important part in nitrogen utilization, and hence, nitrogen yield. There was little or no difference between fall and spring applications but the difference between these dates and summer applied nitrogen amounted to approximately 4 pounds or 10 percent of the total nitrogen yield in these plots.

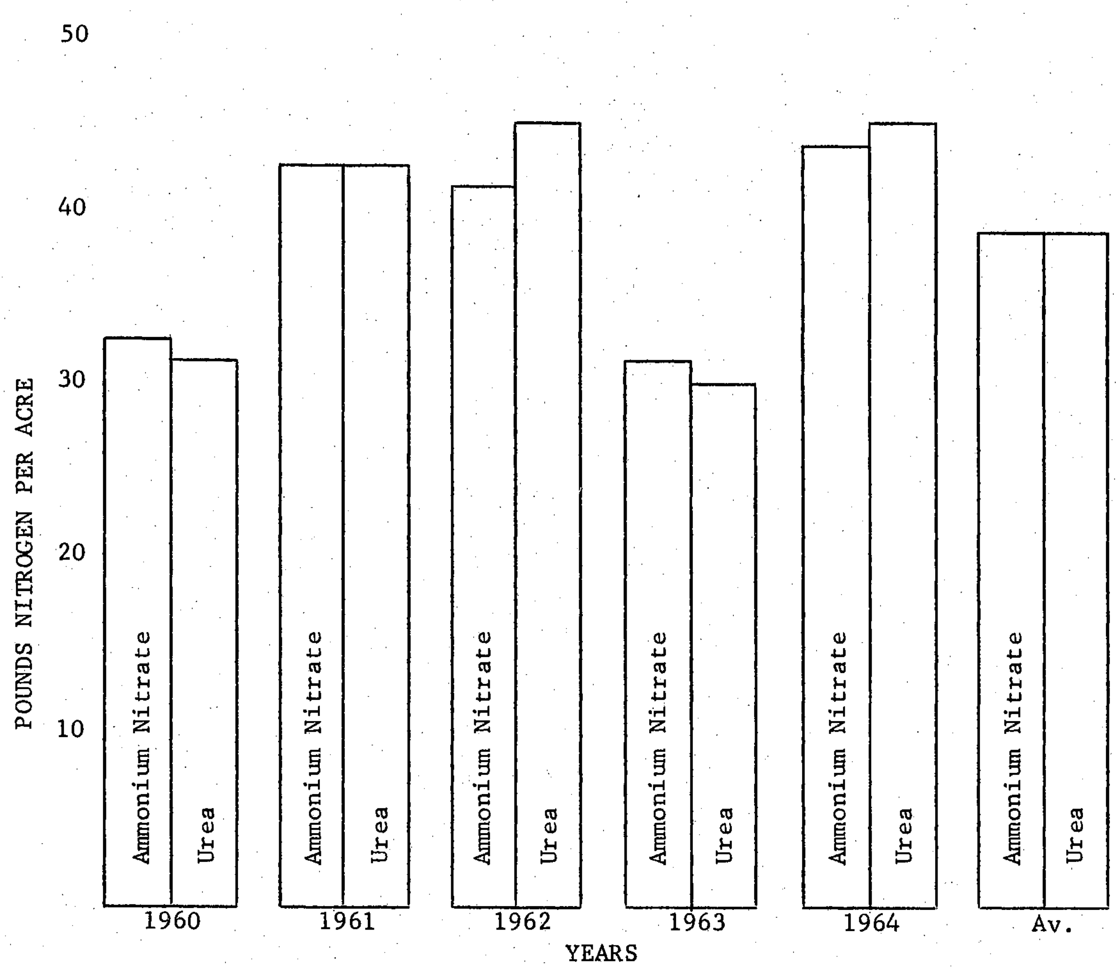

Figure 4. Yield of Nitrogen in Pounds Per Acre as Influenced by Source of Nitrogen

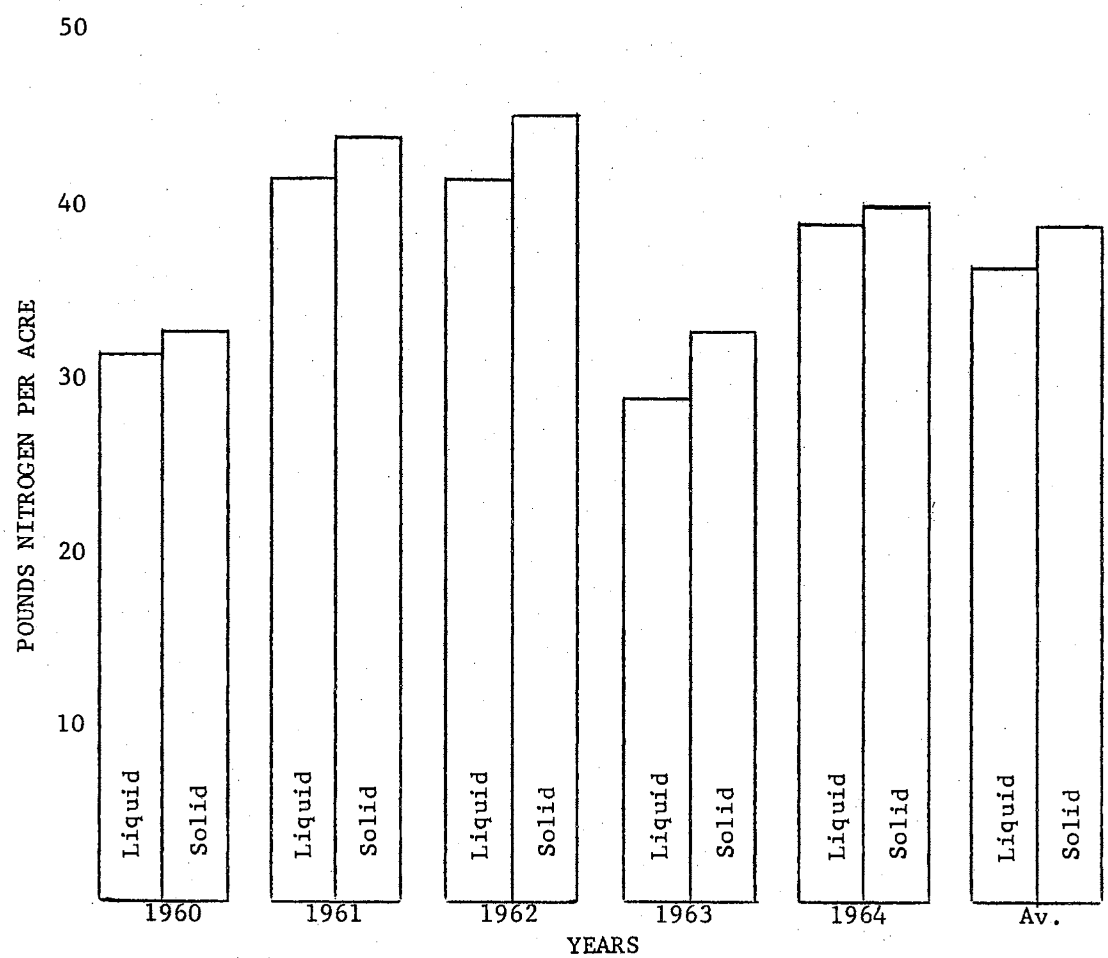

Figure 5. Yield of Nitrogen in Pounds Per Acre as Influenced by Form of Nitrogen Application

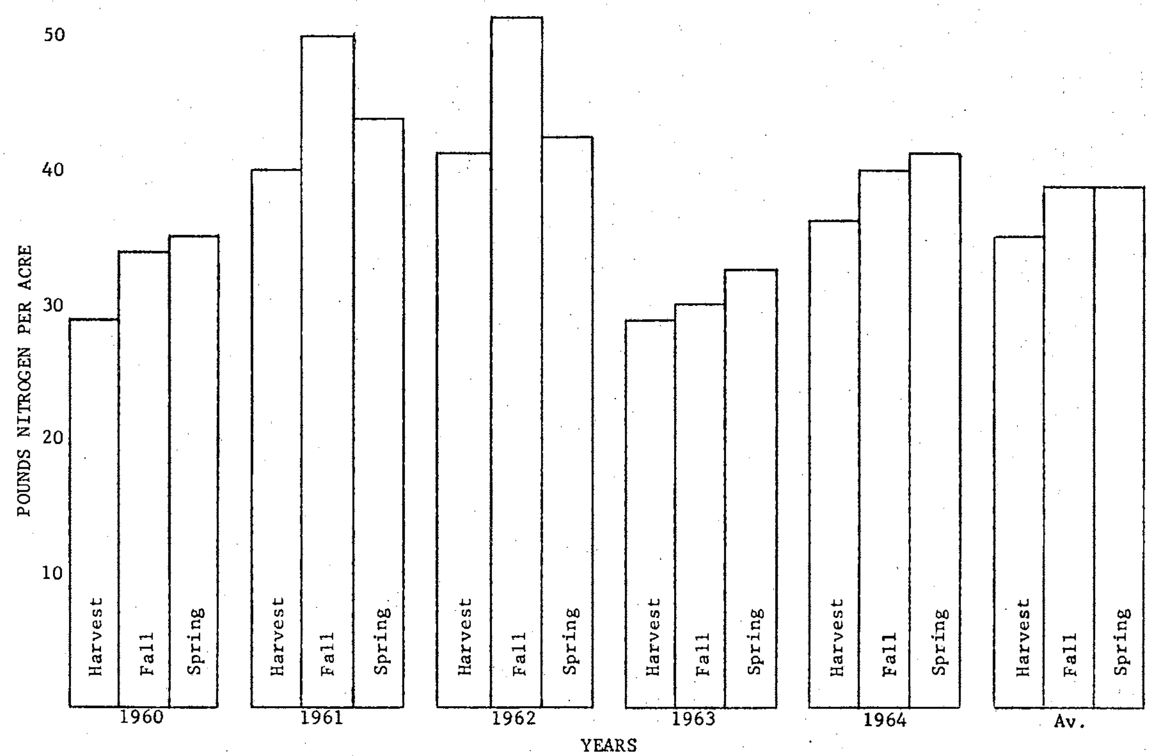

Figure 6. Yield of Nitrogen in Pounds Per Acre as Influenced by Time of Application

Straw Yield

Only three years data were obtained for the study of straw yield, (Appendix Tables XVI, XVII, XVIII, and XIX). It was evident, however, that the factors which were most beneficial for grain yields were also most beneficial for straw yields (Figures 7, 8 and 9). The most straw was obtained from plots where solid fertilizers were used and where the fertilizers were applied in the fall. As with grain yield, no difference was noted between sources of nitrogen. Data analysis are given in Appendix Tables XXII and XXIII.

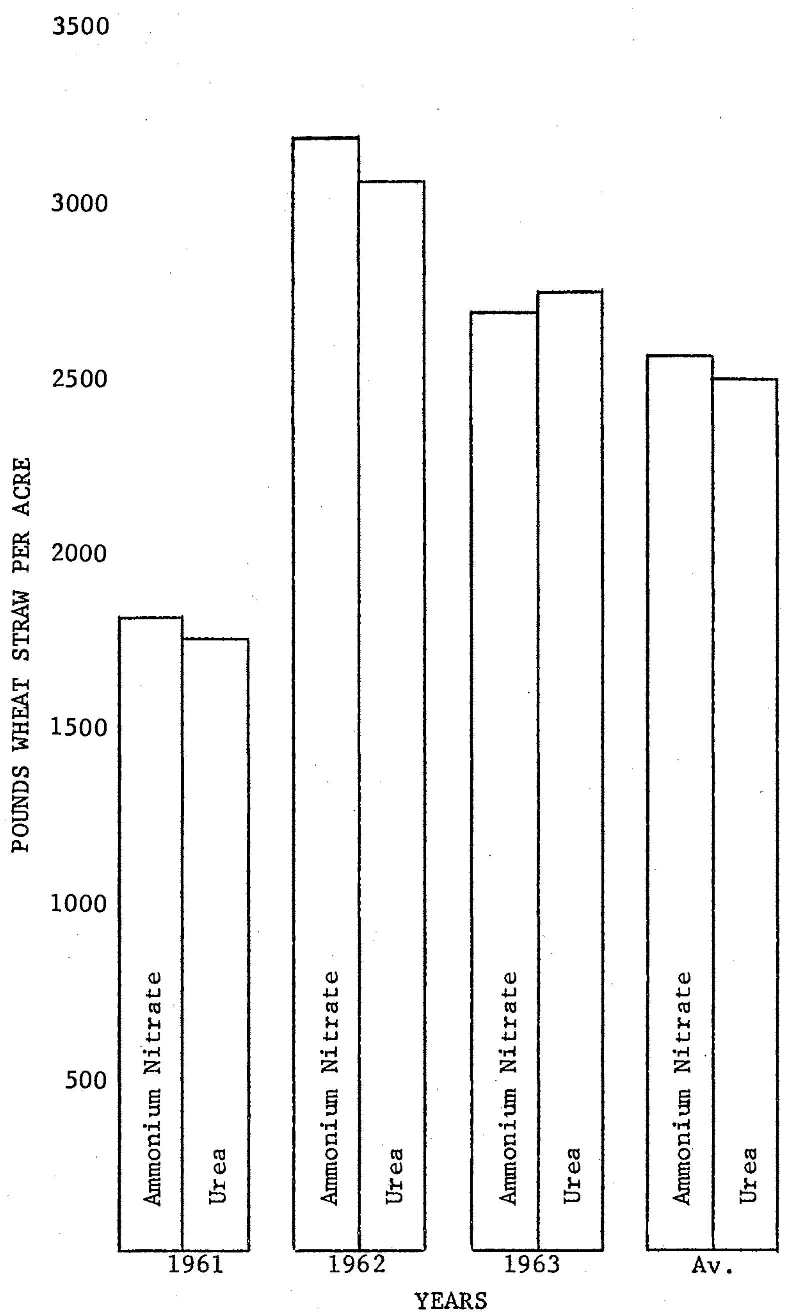

Figure 7. Yield of Wheat Straw as Influenced by Source of Nitrogen

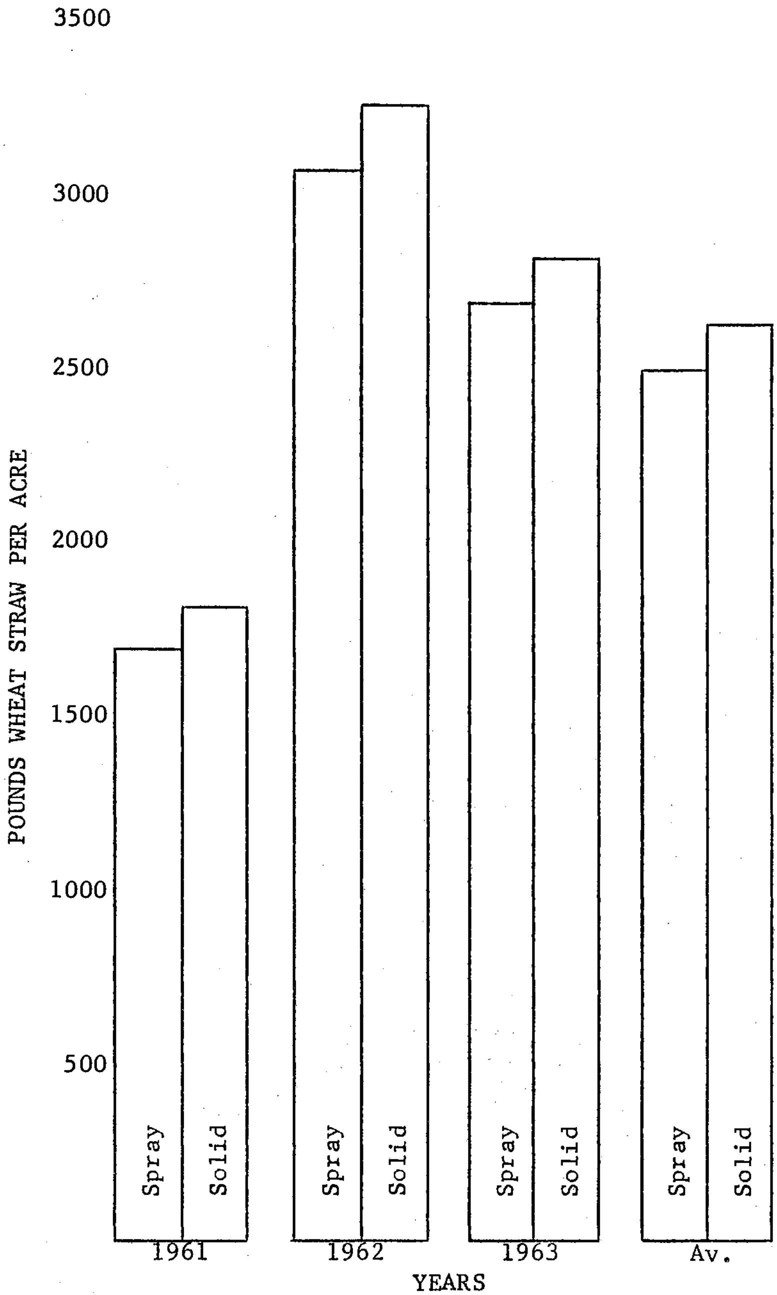

Figure 8. Wheat Straw Yield in Pounds Per Acre as Influenced by Form of Nitrogen Application

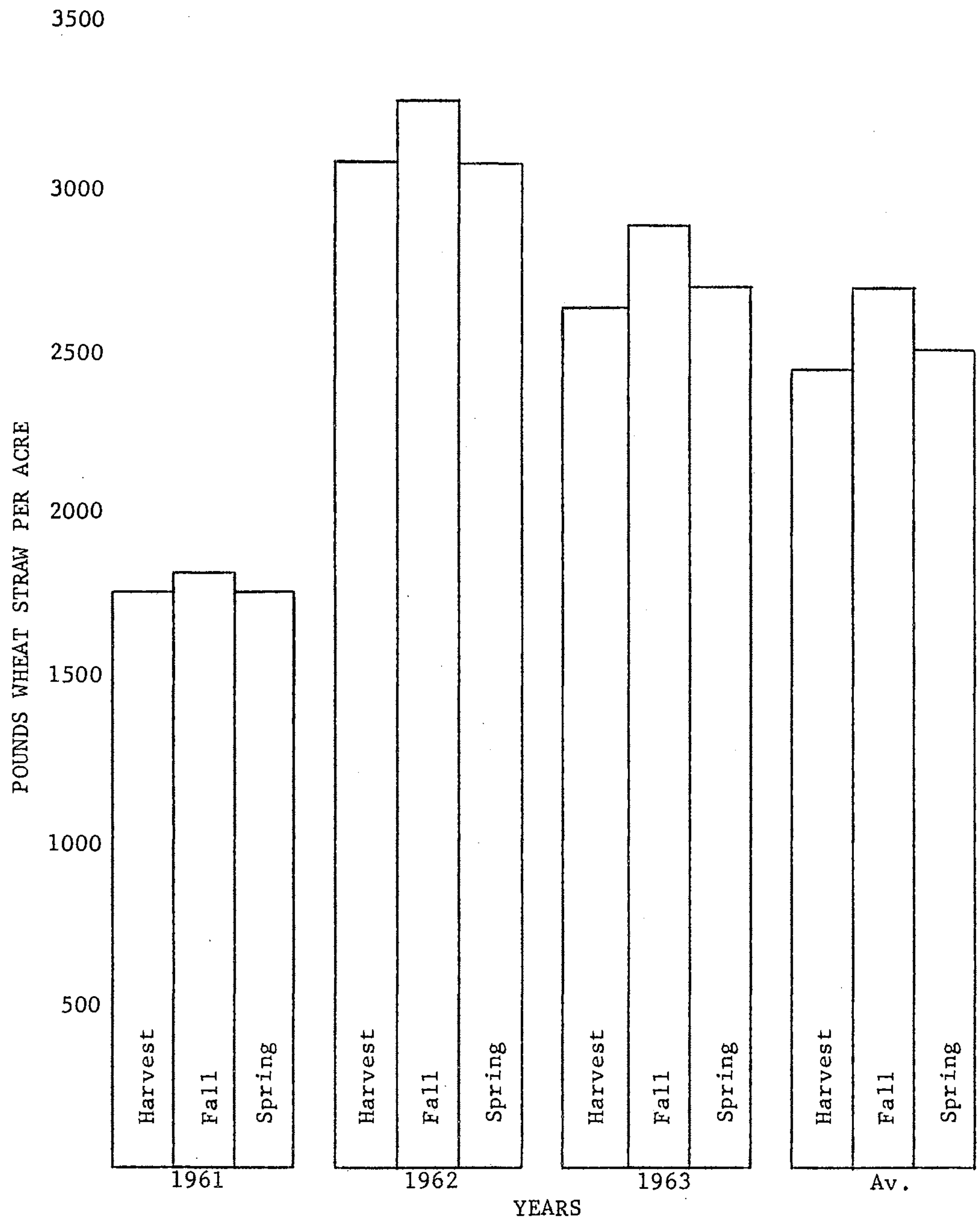

Figure 9. Wheat Straw Yield in Pounds Per Acre as Influenced by Dates of Application

CHAPTER IV

CONCLUSIONS

It was clearly evident throughout the study that climatic factors, particularly rainfall, were more important in the determination of grain, straw or nitrogen yields than the factors involved in nitrogen fertilization.

Over the 5 year period, however, there was a definite advantage in grain, straw and total nitrogen yields with the use of the solid forms of nitrogenous fertilizers. This difference was not reflected in the percent of nitrogen in the grain, however. The percent of nitrogen in the grain was higher when urea was used than when ammonium nitrate was used, but this difference was not reflected in the yields of grain, straw or total nitrogen. The date of the application of nitrogenous fertilizer did not appreciably influence the percent of nitrogen in the grain, but grain and straw yields were highest when fertilization was accomplished in the fall. The yield of total nitrogen was greatest, however, following either fall or spring application and by far the lowest following summer application.

The results of this study indicate that grain, straw and total nitrogen yields can be significantly increased with the use of solid nitrogenous fertilizers applied at the time of planting in the fall compared with liquid fertilizers applied as sprays, or with liquid or solid materials applied post-harvest or in the spring.

The percent of nitrogen in the grain can be increased with the use of urea applied either in the fall or spring compared with ammonium nitrate, or with either urea or ammonium nitrate applied post-harvest.

Although the differences appeared small, they were consistent throughout the study. Indeed, the average differences between the grain yield of plots fertilized with the solid versus the liquid forms, for example, approached an average 5 percent of the total yield of these plots over the 5 year period. These differences are perhaps of little practical significance.

CHAPTER V

SUMMARY

The sources of nitrogen used in the study, ammonium nitrate and urea, did not influence the grain, straw or total nitrogen yield, but urea was superior to ammonium nitrate in the percent of nitrogen in the grain.

The solid forms of urea and ammonium nitrate were superior to the liquid forms in grain, straw and total nitrogen yields, but the form had no effect on the percent of nitrogen in the grain.

Fall applications of nitrogenous fertilizers were superior to spring and post-harvest applications in grain and straw yields. There was no difference between fall and spring applications in total nitrogen yield or percent of nitrogen in the grain, but these dates of application were far superior to post-harvest applications.

There were no significant interactions found in the study except those involving years, or in reality, climatic factors.

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APPENDIX

Profile Description of the Grant Silt Loam

Ap	0-6"	Brown (10YR 5/3) silt loam; dark brown (10YR 3/3) when moist; weak, granular structure; hard when dry, friable when moist; roots abundant; noncalcareous; abrupt boundary.
A_1	6-8	Brown (10YR 5/3) silt loam; dark brown (10YR 3/3) when moist; weak, granular structure; compact and very hard when dry; very few pores; noncalcareous; clear boundary.
A_3	8-20"	Reddish-brown (5YR 4/3) loam; dark reddish brown (5YR 3/3) when moist; moderate, fine, subangular blocky and granular structure; hard when dry, friable when moist; many worm-casts; noncalcareous; contains a few very small pebbles; gradual boundary.
B_{2t}	20-46"	Yellowish-red (5YR 4/6) loam; moderate medium granular and subangular blocky structure; hard when dry, friable when moist; noncalcareous; gradual boundary.
B_3	46-72"	Red (2.5YR 4/6) silt loam; weak, subangular blocky structure; friable when moist; weakly calcareous; contains a few small pebbles; diffuse boundary.
C	72" +	Red (2.5YR 4/6) loamy fine sand; very friable when moist; contains a few small Ca CO_3 concretions; weakly calcareous.

TABLE I

THE YIELD OF GRAIN FOLLOWING APPLICATION OF TWO SOURCES AND TWO FORMS OF NITROGEN FERTILIZER APPLIED AT THREE DIFFERENT DATES AT CHEROKEE, OKLAHOMA, FOR THE CROP YEARS 1960 THROUGH 1964

		NH_4NO_3						Urea					
		Liquid			Solid			Liquid			Solid		
Year	Rep.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.
1960	I	35.3	32.4	32.8	32.9	37.4	30.5	25.2	30.7	34.4	29.3	31.4	32.6
	II	29.7	33.4	28.9	31.2	36.1	34.4	26.5	29.6	30.2	37.1	27.9	31.5
	III	24.1	30.0	29.8	29.4	36.9	36.4	22.6	30.3	33.7	23.6	34.4	33.8
	IV	28.4	31.9	34.8	35.7	37.1	29.3	31.6	33.5	33.9	34.3	31.7	31.1
	$\bar{X}$	29.4	31.9	31.6	32.3	36.9	32.7	26.5	31.0	33.1	31.1	31.4	32.3
1961	I	29.1	29.6	29.8	28.7	28.9	29.8	24.2	30.0	27.3	29.1	27.3	30.6
	II	29.4	29.6	35.5	32.0	37.0	38.2	31.6	30.4	29.3	35.3	34.7	33.9
	III	31.6	31.6	29.6	29.1	26.7	35.6	31.6	28.5	28.5	31.2	35.8	30.2
	IV	28.7	25.8	35.5	28.5	35.8	28.7	30.6	32.5	27.9	33.3	32.5	26.0
	$\bar{X}$	29.7	29.2	32.6	29.6	32.1	33.1	29.5	30.4	28.3	32.2	32.6	30.2
1962	I	29.1	30.8	27.6	30.0	30.4	30.8	26.3	31.7	27.3	31.8	29.6	28.5
	II	28.9	30.9	31.3	31.8	32.1	32.6	29.4	30.7	29.9	34.0	30.7	31.3
	III	27.6	25.7	26.5	24.7	28.9	29.1	28.6	27.1	26.7	32.5	31.7	35.3
	IV	30.9	25.8	28.0	27.2	36.8	30.8	27.9	33.6	31.4	34.9	34.5	26.1
	$\bar{X}$	29.1	28.3	28.4	28.4	32.1	30.8	28.1	30.8	28.8	33.3	31.6	30.3
1963	I	19.3	18.2	20.1	19.7	20.1	18.6	19.0	18.6	20.9	16.8	19.9	21.3
	II	18.0	16.6	20.7	19.7	23.4	23.8	18.2	20.5	19.9	16.8	23.4	19.3
	III	17.4	19.0	21.5	18.0	19.9	19.5	18.2	17.6	15.5	19.0	20.9	19.7
	IV	17.0	17.6	18.6	23.2	18.2	22.2	20.5	14.7	17.6	17.2	18.2	23.4
	$\bar{X}$	17.9	17.9	20.2	20.2	20.4	21.0	19.0	17.9	18.5	17.7	20.6	20.4
1964	I	29.0	29.6	26.7	28.6	24.6	28.2	27.2	29.5	27.2	28.7	28.8	28.8
	II	28.4	32.1	28.7	31.4	30.1	32.6	31.2	32.3	27.0	31.0	31.4	30.5
	III	27.6	28.1	27.4	27.1	29.8	29.2	29.5	29.3	25.7	29.7	29.7	33.4
	IV	30.1	28.6	30.4	29.2	31.2	29.9	31.4	31.1	30.9	31.5	33.3	27.7
	$\bar{X}$	28.8	29.7	28.3	29.0	28.9	30.0	29.9	30.6	27.4	30.3	30.7	30.1

TABLE II

A COMPARISON OF AMMONIUM NITRATE AND UREA SOURCES OF NITROGEN FOR WHEAT GRAIN YIELD AT CHEROKEE, OKLAHOMA

Nitrogen Source	Grain Yield in Bushels Per Acre					5-Year
	1960	1961	1962	1963	1964	Average
Ammonium Nitrate	32.5	31.0	29.5	19.6	29.6	28.4
Urea	30.9	30.5	30.5	19.1	29.8	28.1
Difference*	1.6	0.5	1.0	0.5	0.2	0.3

*Differences were not significant.

TABLE III

A COMPARISON OF FORMS OF NITROGEN FERTILIZER FOR WHEAT GRAIN YIELD AT CHEROKEE, OKLAHOMA

Fertilizer Form	Grain Yield in Bushels Per Acre					5-Year
	1960	1961	1962	1963	1964	Average
Solid	32.8	31.6	31.1	20.1	29.2	28.9
Liquid	30.6	29.9	28.9	18.6	29.1	27.4
Difference	2.2**	1.7*	2.1*	1.5**	0.1	1.5**

*Difference significant at 5 percent level

**Difference significant at 1 percent level

TABLE IV

A COMPARISON OF DATES OF NITROGEN APPLICATION FOR WHEAT GRAIN YIELD AT CHEROKEE, OKLAHOMA

Application Date	Grain Yield in Bushels Per Acre 1960	1961	1962	1963	1964	5-Year Average
Harvest	29.8	30.1	29.7	18.6	29.6	27.6
Fall	32.8	31.0	30.7	19.2	30.0	28.7
Spring	32.4	31.0	29.6	20.2	28.9	28.4
Maximum Difference	3.0	0.9*	1.1	1.6	1.1	1.1*

*Difference significant at 5 percent level

TABLE V

ANALYSIS OF VARIANCE OF WHEAT GRAIN YIELDS BY YEARS

Source	dF	1960 MS	1960 F cal	1960 F tab	1961 MS	1961 F cal	1961 F tab
Total	47						
Reps	3	3.21	0.94	2.92	12.17	1.31	2.92
Source	1	3.63	1.06	4.17	29.92	3.23	4.17
Form	1	28.52	8.31**	4.17	56.98	6.15*	4.17
Date	2	9.71	2.83	3.32	41.94	4.53*	3.32
Source x Form	1	1.21	0.35	4.17	7.77	0.84	2.92
Source x Date	2	1.28	0.37	3.32	14.77	1.60	3.32
Form x Date	2	5.32	1.55	3.32	13.77	1.49	3.32
Source x Form x Date	2	7.81	2.28	3.32	9.98	1.08	3.32
Error A	33	3.43			9.26		

Source	dF	1962 MS	1962 F cal	1962 F tab	1963 MS	1963 F cal	1963 F tab
Total	47						
Reps	3	38.73	5.51*	2.92	14.67	2.70	2.92
Source	1	3.25	0.46	4.17	11.21	2.06	4.17
Form	1	34.51	4.91*	4.17	57.20	10.53**	4.17
Date	2	3.28	0.47	3.32	5.83	1.07	3.32
Source x Form	1	4.26	0.61	4.17	1.41	0.26	4.17
Source x Date	2	29.06	4.13*	3.32	3.72	0.69	3.32
Form x Date	2	2.39	0.34	3.32	.14	0.03	3.32
Source x Form x Date	2	3.24	0.46	3.32	21.70	4.00*	3.32
Error A	33	7.03			5.43		

TABLE VI

ANALYSIS OF VARIANCE OF WHEAT GRAIN YIELD DATA POOLED FOR YEARS 1960 - 1963

Source	dF	MS	F cal	F tab
Reps	3	29.47	3.68*	2.92
Source	1	8.50	1.06	4.17
Form	1	173.28	21.66**	4.17
Date	2	33.85	4.23*	3.32
Source x Form	1	.10	0.01	4.17
Source x Date	2	4.71	0.59	3.32
Form x Date	2	6.87	0.86	3.32
Source x Form x Date	2	13.71	1.71	3.32
Error A	33	8.00		
Years	3	1606.13	281.78**	2.70
Years x Source	3	13.18	2.31	2.70
Years x Form	3	1.31	0.23	2.70
Years x Date	6	8.97	1.57	2.19
Year x Source x Form	3	4.84	0.85	2.70
Year x Source x Date	6	14.70	2.58*	2.19
Year x Form x Date	6	4.92	0.86	2.19
Year x Source x Form x Date	6	9.68	1.70	2.19
Year x Rep	9	13.10	2.30*	1.97
Error B	99	5.70		
Total SS	191	33.73		

TABLE VII

METEROLOGICAL DATA FROM JULY 1, 1959, THROUGH JUNE 30, 1960, AT THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Month	Temperature Degrees Fahrenheit				Humidity Percent			Wind Movement Miles Per Hour[1]			Evaporation[2]	Number of Storms	Precipitation		
			Average												
	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Max.	Min.	Avg.	Total Inches		Storms Causing Runoff[3]	Total Inches[4]	Departure from Avg. Inches[5]
July	97	52	87	65	98	27	64	10.1	2.7	5.6	8.34	4	0	.66	-1.41
August	102	61	93	68	96	30	60	12.8	4.8	8.4	10.59	4	0	1.69	-1.28
September	94	41	83	61	100	26	65	22.0	.4	7.6	6.24	5	3	6.22	+3.57
October	84	29	65	45	100	27	70	12.3	2.8	6.6	3.80	4	2	5.08	+2.85
November	75	5	49	27	100	26	62	13.1	5.1	8.1	--	1	0	.13	-1.23
December	67	19	48	31	100	27	70	21.4	1.3	7.1	--	4	0	1.15	+0.22
January	65	9	38	24	100	36	73	18.2	2.0	6.4	--	3	1	1.15	+0.35
February	64	4	35	21	100	39	76	14.4	2.6	8.3	--	5	1	1.67	+0.77
March	85	-3	48	29	100	34	76	14.0	4.7	7.8	--	4	0	.78	-0.74
April	94	34	73	51	96	24	65	15.7	2.8	8.4	5.34	3	0	.90	-1.99
May	91	32	79	53	97	30	67	9.3	1.8	5.2	5.60	8	1	4.66	+0.77
June	107	54	90	66	96	28	63	13.4	1.7	6.1	7.54	11	2	3.35	-0.46
Yearly	107	-3	66	45	100	24	71	21.4	.4	7.1	47.85	56	10	27.44	+1.39

[1]Average for twenty-four hour period; measured at 2.5 feet above ground level

[2]Warm season only; measured from open metal tank

[3]Storms causing runoff from at least one plot

[4]Average of ten rain gages

[5]Based on weather bureau records in Cherokee, Oklahoma, since 1915

TABLE VIII

METEROLOGICAL DATA FROM JULY 1, 1960, THROUGH JUNE 30, 1961, AT THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Month	Temperature Degrees Fahrenheit				Humidity Percent			Wind Movement Miles Per Hour[1]			Evaporation[2] Total Inches	Number of Storms	Precipitation		
			Average										Storms Causing Runoff[3]	Total Inches[4]	Departure from Avg. Inches[5]
	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Max.	Min.	Avg.					
July	105	59	90	69	97	28	62	11.3	1.9	5.3	6.20	5	3	5.59	+3.44
August	105	60	95	69	99	29	64	11.8	2.3	7.2	8.18	4	2	2.80	-0.17
September	97	50	87	63	96	24	60	10.0	1.8	5.4	5.65	4	3	2.34	-0.31
October	93	32	75	50	98	22	50	10.6	1.2	4.8	2.18	4	4	3.60	+1.33
November	75	21	59	34	100	28	64	11.6	1.8	5.5	--	2	1	0.35	-0.98
December	64	11	41	27	100	30	65	10.9	1.8	6.3	--	2	1	1.36	+0.42
January	62	7	44	20	100	26	63	12.0	1.7	5.1	--	1	0	0.08	-0.79
February	72	14	48	29	100	26	63	12.7	1.3	5.5	--	2	0	0.29	-0.57
March	76	24	57	36	91	25	58	12.6	2.7	6.3	--	5	2	4.16	+2.59
April	88	29	65	42	90	25	58				4.54	5	1	1.44	-1.42
May	91	35	73	53	94	28	61				5.47	5	3	5.26	+1.34
June	99	52	85	63	92	28	60				6.32	7	2	5.24	+1.40
Yearly	105	7	68	46	100	22	61	12.7	1.2	5.7	38.54	46	22	32.51	+6.30

[1]Average for twenty-four hour period; measured at 2.5 feet above ground level. Anemometer was out of order from April 1, 1961 through June, 1961.

[2]Warm season only; measured from open metal tank

[3]Storms causing runoff from at least one plot

[4]Average of ten rain gages

[5]Based on weather bureau records in Cherokee, Oklahoma since 1915

TABLE IX

METEROLOGICAL DATA FROM JULY 1, 1961 THROUGH JUNE 30, 1962, AT THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Month	Temperature Degrees Fahrenheit				Humidity Percent			Wind Movement, Miles Per Hour[1]			Evaporation[2]	Number of Storms	Precipitation		
			Average												
	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Max.	Min.	Avg.	Total Inches		Storms Causing Runoff[3]	Total Inches[4]	Departure from Avg. Inches[5]
July	102	55	92	67	94	29	61	[6]	--	--	9.01	4	2	1.66	-.48
August	102	54	88	67	94	24	59	[6]	--	--	7.48	5	1	2.54	-.42
September	102	42	77	58	92	24	66	[6]	--	--	5.35	6	1	3.16	+.50
October	85	30	71	48	99	21	60	18.5	1.7	7.0	4.37	4	1	1.98	-.28
November	65	26	50	35	96	34	65	12.2	1.3	6.3	--	2	2	2.19	+.84
December	65	-4	38	24	98	34	66	12.1	2.1	5.7	--	3	--	.94	.00
January	68	-4	35	18	100	30	65	13.7	1.7	6.8	--	3	--	.34	-.45
February	88	4	51	30	99	25	64	13.2	2.8	6.8	--	1	--	.10	-.75
March	83	9	57	32	100	22	58	15.4	1.5	7.9	--	2	--	.26	-1.28
April	86	31	69	45	100	30	68	16.5	.6	5.9	4.73	5	1	2.36	-.49
May	100	44	89	62	100	20	63	12.9	2.7	8.1	8.96	3	1	1.67	-2.20
June	95	55	87	64	100	34	71	14.5	2.1	5.9	8.39	11	3	5.32	+1.45
Yearly	102	-4	67	46	100	20	64	14.3	1.8	6.7	48.29	49	12	22.53	-3.59

[1] Average for twenty-four hour period; measured at 2.5 feet above ground level

[2] Warm season only; measured from open metal tank

[3] Storms causing runoff from at least one plot

[4] Average of ten rain gages

[5] Based on weather bureau records in Cherokee, Oklahoma since 1915

[6] Anemometer out of order

TABLE X

METEROLOGICAL DATA FROM JULY 1, 1962, THROUGH JUNE 30, 1963, AT THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Month	Temperature Degrees Fahrenheit				Humidity Percent			Wind Movement Miles Per Hour[1]			Evaporation[2] Total Inches	Number of Storms	Precipitation		
			Average										Storms Causing Runoff[3]	Total Inches[4]	Departure From Avg. Inches[5]
	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Max.	Min.	Avg.					
July	105	63	94	71	100	26	65	21.3	.3	7.6	8.13	6	2	4.57	+2.43
August	110	51	97	68	100	26	59	11.9	2.1	6.0	9.47	2	0	2.35	-2.61
September	103	39	81	60	100	26	74	14.8	1.2	5.8	5.37	10	1	3.32	+ .66
October	94	32	75	51	100	28	67	12.8	1.7	3.5	3.52	3	0	.99	-1.27
November	74	26	58	35	100	26	76	12.6	1.7	4.9	--	3	0	1.02	- .33
December	71	-5	48	26	100	27	68	8.8	1.1	4.5	--	2	0	.73	- .21
January	69	10	38	13	100	20	62	17.5	1.6	6.2	--	1	0	.38	- .40
February	75	12	53	24	100	18	58	13.4	1.7	6.2	--	1	0	.08	- .77
March	89	19	65	37	100	11	56	16.0	1.9	7.4	--	4	0	1.31	- .23
April	95	34	74	48	98	16	59	13.1	2.1	6.6	5.99	5	2	2.18	- .67
May	98	38	82	58	96	22	65	14.7	1.8	6.2	5.76	7	1	2.07	-1.80
June	99	56	90	67	100	30	65	[6]	--	--	7.46	8	4	8.58	+4.71
Yearly	110	-10	71	46	100	11	64	21.3	.3	5.9	45.70	52	10	25.56	- .56

[1] Average for twenty-four hour period; measured at 2.5 feet above ground level

[2] Warm season only; measured from open metal tank

[3] Storms causing runoff from at least one plot

[4] Average of ten rain gages

[5] Based on weather bureau records in Cherokee, Oklahoma since 1915

[6] Anemometer out of order

TABLE XI

METEROLOGICAL DATA FROM JULY 1, 1963, THROUGH JUNE 30, 1964, AT THE WHEATLAND CONSERVATION EXPERIMENT STATION, CHEROKEE, OKLAHOMA

Month	Temperature Degrees Fahrenheit				Humidity Percent			Wind Movement Miles Per Hour[1]			Evaporation[2] Total Inches	Number of Storms	Precipitation		
			Average										Storms Causing Runoff[3]	Total Inches[4]	Departure From Avg. Inches[5]
	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Max.	Min.	Avg.					
July	107	65	97	72	100	25	60	12.0	2.4	7.2	9.03	7	1	4.90	+2.66
August	107	58	96	71	97	25	58	10.8	2.9	5.9	9.41	4	1	1.69	-1.19
September	98	44	86	65	99	22	68	9.3	1.7	4.7	4.09	6	2	3.92	+1.22
October	97	38	85	56	100	20	58	10.4	2.2	5.7	5.47	4	0	.73	-1.47
November	80	23	61	36	100	27	63	12.4	1.3	5.4	--	2	0	1.35	+ .01
December	67	-5	39	19	100	26	70	12.0	2.1	5.2	--	3	0	.13	- .79
January	73	0	53	24	100	18	54	17.7	2.5	6.6	--	1	0	.72	- .05
February	62	15	48	27	99	23	61	14.4	1.9	6.3	--	3	0	.89	+ .06
March	81	13	57	31	100	18	56	18.4	2.5	8.2	--	2	0	.60	- .92
April	88	27	75	48	93	14	54	15.7	1.8	7.7	6.31	4	2	2.10	- .70
May	100	42	83	59	92	14	60	14.0	3.4	7.0	7.25	9	0	2.07	-1.73
June	103	44	92	66	60	22	56	16.5	1.8	7.0	8.73	8	2	3.30	- .65
Yearly	107	-5	97	19	100	14	65	18.4	1.3	6.4	50.29	53	8	22.41	-3.62

[1]Average for twenty-four hour period; measured at 2.5 feet above ground level

[2]Warm season only; measured from open metal tank

[3]Storms causing runoff from at least one plot

[4]Average of ten rain gages

[5]Based on weather bureau records in Cherokee, Oklahoma since 1915

TABLE XII

THE YIELD OF NITROGEN FOLLOWING APPLICATION OF TWO SOURCES AND TWO FORMS OF NITROGEN FERTILIZER APPLIED AT THREE DIFFERENT DATES AT CHEROKEE, OKLAHOMA, FOR THE CROP YEARS 1960 THROUGH 1963

		NH_4NO_3						Urea					
		Spray			Solid			Spray			Solid		
Year	Rep.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.
1960	I	41.46	31.93	20.13	31.84	37.98	36.49	23.34	37.36	56.04	32.98	33.96	38.70
	II	34.85	32.34	27.65	33.07	34.07	32.08	22.44	31.84	34.18	33.69	26.17	39.24
	III	19.22	29.72	27.61	24.57	36.52	32.55	17.96	26.43	34.83	19.81	31.66	30.46
	IV	35.58	32.39	30.12	35.21	43.56	29.97	26.78	30.23	39.19	39.89	39.17	28.42
	$\bar{X}$	32.78	31.59	28.88	31.17	38.03	32.77	22.63	31.47	41.06	29.09	32.74	34.21
1961	I	40.86	37.70	37.76	39.39	50.04	43.85	26.00	41.79	43.59	40.10	49.81	40.76
	II	45.75	43.75	47.43	44.49	47.73	47.39	37.13	46.71	46.86	44.42	55.54	49.94
	III	34.85	47.17	39.30	36.27	28.55	42.34	36.94	37.58	38.78	34.81	40.45	42.07
	IV	46.45	42.04	45.03	36.55	49.46	37.18	38.02	44.32	44.18	47.38	52.13	41.12
	$\bar{X}$	41.98	42.67	42.38	39.18	43.95	42.69	34.52	42.60	43.35	41.68	49.48	43.47
1962	I	42.60	43.24	40.41	43.38	48.52	42.32	33.30	46.79	45.86	49.23	43.87	44.80
	II	39.88	47.86	42.26	44.46	46.42	41.47	39.51	54.71	42.34	40.39	49.73	54.65
	III	37.43	37.78	34.34	29.05	41.44	39.11	33.98	35.12	38.13	43.10	45.65	48.71
	IV	50.80	42.11	32.26	36.88	55.42	43.43	36.49	53.02	45.97	50.26	47.86	43.53
	$\bar{X}$	42.68	42.65	37.32	38.44	47.95	41.58	35.82	47.41	43.08	45.75	46.78	47.92
1963	I	26.84	25.25	29.52	28.44	30.60	30.18	27.30	28.50	32.75	26.97	31.36	34.28
	II	27.88	26.93	35.02	31.39	35.93	36.14	28.53	29.51	29.81	27.17	36.63	31.42
	III	26.40	29.93	35.14	27.77	34.34	33.51	29.19	29.25	24.32	33.36	33.87	32.57
	IV	25.56	27.56	30.40	36.58	27.55	36.68	31.47	23.20	28.72	26.90	27.44	38.87
	$\bar{X}$	26.67	27.42	32.52	31.05	32.11	34.13	29.12	27.62	28.90	28.60	32.33	34.29
1964	I	19.23	19.54	18.06	18.89	16.70	18.88	17.88	19.69	18.73	19.11	19.34	19.31
	II	18.89	20.99	19.25	20.57	19.83	21.42	20.29	21.20	18.30	20.24	20.89	20.36
	III	18.07	18.67	18.27	17.72	19.49	19.36	19.28	19.14	17.35	19.34	19.80	21.76
	IV	20.11	19.09	20.18	19.34	20.55	19.66	20.39	20.47	20.24	20.47	21.82	18.18
	$\bar{X}$	19.07	19.61	18.96	19.13	19.15	19.87	19.50	20.16	18.46	19.83	20.45	19.92

TABLE XIII

A COMPARISON OF AMMONIUM NITRATE AND UREA SOURCES OF NITROGEN FOR POUNDS NITROGEN REMOVED PER ACRE AT CHEROKEE, OKLAHOMA

Nitrogen Source	1960	1961	1962	1963	1964	5-Year Average
Ammonium Nitrate	32.54	42.14	41.77	30.65	43.53	38.12
Urea	31.87	42.52	44.46	30.14	45.01	38.80
Difference*	0.67	0.38	2.69	0.51	1.48	0.68

TABLE XIV

A COMPARISON OF FORMS OF NITROGEN FERTILIZER FOR POUNDS NITROGEN REMOVED PER ACRE AT CHEROKEE, OKLAHOMA

Fertilizer Form	1960	1961	1962	1963	1964	5-Year Average
Solid	33.00	43.41	44.74	32.08	39.66	38.58
Liquid	31.40	41.25	41.49	28.71	38.21	36.21
Difference*	1.60	2.16	2.25	3.37	1.45	2.37

TABLE XV

A COMPARISON OF DATES OF NITROGEN APPLICATION FOR POUNDS NITROGEN REMOVED PER ACRE AT CHEROKEE, OKLAHOMA

Application Date	1960	1961	1962	1963	1964	5-Year Average
Harvest	28.92	39.34	40.67	28.86	35.82	34.72
Fall	33.46	44.67	46.20	29.87	40.07	38.85
Spring	34.23	42.97	42.47	32.46	40.92	38.61
Maximum Difference*	5.31	5.33	5.53	3.60	5.10	4.13

TABLE XVI

THE YIELD OF STRAW FOLLOWING APPLICATION OF TWO SOURCES AND TWO FORMS OF NITROGEN FERTILIZER APPLIED AT THREE DIFFERENT DATES AT CHEROKEE, OKLAHOMA, FOR THE CROP YEARS 1961 THROUGH 1963

		NH_4NO_3						Urea					
		Liquid			Solid			Liquid			Solid		
Year	Rep.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.	Har.	Fall	Spr.
1961	I	1902.6	1755.9	1586.7	1755.9	1331.0	1819.8	1590.5	1669.4	703.1	1669.4	2004.1	1631.8
	II	1955.2	2000.3	1413.8	1669.4	1928.9	2019.1	1831.1	1955.2	2064.2	2015.4	1748.4	1959.0
	III	1443.8	1688.2	1560.4	1729.6	1831.1	1665.7	1466.4	1586.7	1740.9	1477.7	1613.0	2090.6
	IV	1962.7	2037.9	1804.8	1763.4	2124.4	1970.2	1473.9	1759.7	1955.2	1699.5	2049.2	1786.0
	$\bar{X}$	1816.0	1870.5	1591.4	1729.5	1803.8	1868.7	1590.4	1742.7	1615.8	1715.5	1853.6	1866.8
1962	I	3379.3	3574.1	2631.0	3199.5	3353.2	4203.6	2354.3	2752.1	2448.3	3447.2	3249.6	3622.2
	II	3257.4	3472.7	2701.9	2713.4	3194.5	3039.1	3227.3	3264.4	3214.5	2758.4	4230.6	2536.1
	III	2717.1	3022.5	2498.1	3296.3	2539.7	3083.0	2928.8	2524.7	2567.0	2770.3	2831.8	2913.3
	IV	3675.7	2832.4	3191.5	2816.4	3690.6	3746.3	3217.1	3370.0	3208.9	3088.9	4171.2	2525.6
	$\bar{X}$	3257.3	3225.4	2755.6	3006.4	3194.5	3518.0	2931.8	2977.8	2859.6	3016.2	3620.8	2899.3
1963	I	2775.4	3195.9	2715.5	2928.0	2976.6	3125.5	2890.6	2875.6	2957.9	3317.3	2880.6	3139.5
	II	3197.4	3369.5	2557.6	3904.8	2804.6	2682.9	2422.2	2861.2	2348.4	2771.6	3182.4	2835.5
	III	2244.1	1908.7	2095.0	2131.2	2452.9	2479.6	2125.4	2184.8	2696.1	2524.0	2959.9	2933.0
	IV	2965.9	2546.4	2254.6	1855.1	3167.4	2612.8	2286.5	3221.6	2825.3	2773.4	3078.4	2789.6
	$\bar{X}$	2795.7	2755.1	2405.6	2454.7	2850.3	2725.2	2431.1	2785.8	2706.9	2846.5	3025.3	2924.4

TABLE XVII

A COMPARISON OF AMMONIUM NITRATE AND UREA SOURCES OF NITROGEN FOR WHEAT STRAW YIELD AT CHEROKEE, OKLAHOMA

Nitrogen Source	Straw Yield in Pounds Per Acre 1961	1962	1963	3-Year Average
Ammonium Nitrate	1780.0	3159.5	2664.4	2534.6
Urea	1730.0	3050.9	2786.7	2522.8
Difference*	50.0	108.6	122.3	11.8

TABLE XVIII

A COMPARISON OF FORMS OF NITROGEN FERTILIZER FOR WHEAT STRAW YIELD AT CHEROKEE, OKLAHOMA

Fertilizer Form	Straw Yield in Pounds Per Acre 1961	1962	1963	3-Year Average
Solid	1806.3	3209.2	2804.4	2606.6
Liquid	1704.5	3001.2	2646.7	2450.8
Difference*	101.8	208.0	157.7	155.8

TABLE XIX

A COMPARISON OF DATES OF NITROGEN APPLICATION FOR WHEAT STRAW YIELD AT CHEROKEE, OKLAHOMA

Application Date	Straw Yield in Pounds Per Acre 1961	1962	1963	3-Year Average
Harvest	1712.9	3052.9	2632.0	2465.9
Fall	1817.7	3254.6	2854.1	2642.1
Spring	1735.7	3008.1	2690.5	2478.1
Maximum Difference	104.8	246.5	222.1	176.2

TABLE XX

ANALYSIS OF VARIANCE OF NITROGEN YIELD DATA BY YEARS

Source	dF	1960 MS	1960 F cal	1960 F tab	1961 MS	1961 F cal	1961 F tab
Total	47						
Reps	3	933.92	0.99	2.92	14866.93	7.11	2.92
Source	1	307.55	0.33	4.17	542.70	0.26	4.17
Form	1	13658.63	14.51	4.17	3078.40	1.47	4.17
Date	2	5515.89	5.86	3.32	13175.50	6.30	3.32
Source x Form	1	40.15	0.04	4.17	2051.50	0.98	4.17
Source x Date	2	454.39	0.48	3.32	17942.85	8.58	3.32
Form x Date	2	773.18	0.82	3.32	3052.80	1.46	3.32
Source x Form x Date	2	1892.71	2.01	3.32	9339.15	4.47	3.32
Error A	33	941.24			2090.03		

Source	dF	1962 MS	1962 F cal	1962 F tab	1963 MS	1963 F cal	1963 F tab
Total	47						
Reps	3	14788.40	7.90	2.92	11144.23	6.04	2.92
Source	1	172.50	0.09	4.17	9675.30	4.70	4.17
Form	1	5585.80	2.98	4.17	12639.30	6.85	4.17
Date	2	11884.75	6.35	3.32	12701.15	6.88	3.32
Source x Form	1	7874.60	4.21	4.17	2585.90	1.40	4.17
Source x Date	2	2791.55	1.49	3.32	3634.10	1.97	3.32
Form x Date	2	1494.90	0.80	3.32	541.45	0.29	3.32
Source x Form x Date	2	2591.45	1.38	3.32	10510.65	5.70	3.32
Error A	33	1872.38			1845.41		

TABLE XXI

ANALYSIS OF VARIANCE OF NITROGEN YIELD DATA POOLED FOR YEARS 1960 - 1963

Source	dF	MS	F cal	F tab
Reps	3	22733.0	11.48	2.92
Source	1	1071.0	0.54	4.17
Form	1	32313.0	11.30	4.17
Date	2	31951.5	16.14	3.32
Source x Form	1	1934.0	0.98	4.17
Source x Date	2	10370.5	5.24	3.32
Form x Date	2	1749.5	0.88	3.32
Source x Form x Date	2	9256.5	4.68	3.32
Error A	33	1980.2		
Years	3	211887.33	133.29	2.70
Years x Source	3	2875.67	1.81	2.70
Years x Form	3	883.00	0.56	2.70
Years x Date	6	3995.17	2.38	2.19
Years x Source x Form	3	3539.33	2.23	2.70
Years x Source x Date	6	4817.50	3.03	2.19
Years x Form x Date	6	1371.00	0.86	2.19
Years x Source x Form x Date	6	5025.83	3.16	2.19
Years x Rep	9	6333.44	3.98	1.97
Error B	99	1589.65		
Total SS	191	6478.47		

TABLE XXII

ANALYSIS OF VARIANCE OF WHEAT STRAW YIELD BY YEARS

Source	1961 dF	1961 MS	1961 F cal	1961 F tab	1962 MS	1962 F cal	1962 F tab
Total	47						
Reps	3	223856.00	4.02	2.92	525936.7	3.16	2.92
Source	1	29028.00	0.52	4.17	141560.0	0.85	4.17
Form	1	124440.00	2.24	4.17	518690.0	3.12	4.17
Date	2	48611.00	0.87	3.32	275815.0	1.66	3.32
Source x Form	1	43899.00	0.79	2.92	27360.0	0.17	4.17
Source x Date	2	17505.00	0.32	3.32	127450.0	0.77	3.32
Form x Date	2	79036.50	1.42	3.32	263465.0	1.58	3.32
Source x Form x Date	2	16546.50	0.30	3.32	530800.0	3.19	3.32
Error A	33	55618.33			166234.2		

Source	1963 dF	1963 MS	1963 F cal	1963 F tab
Total	47			
Reps	3	745477.0	8.82	2.92
Source	1	179267.0	2.12	4.17
Form	1	298463.0	3.53	4.17
Date	2	212045.0	2.51	3.32
Source x Form	1	212561.0	2.52	4.17
Source x Date	2	57104.5	0.68	3.32
Form x Date	2	53763.5	0.64	3.32
Source x Form x Date	2	195348.0	2.28	3.32
Error A	33	84511.0		

TABLE XXIII

ANALYSIS OF VARIANCE OF WHEAT STRAW YIELD DATA POOLED FOR YEARS 1961 - 1963

Source	dF	MS	F cal	F tab
Reps	3	941463.3	6.81	2.92
Source	1	5060.0	0.04	4.17
Form	1	874020.0	6.32	4.17
Date	2	464780.0	3.36	3.32
Source x Form	1	232950.0	1.68	4.17
Source x Date	2	59600.0	0.43	3.32
Form x Date	2	308285.0	2.23	3.32
Source x Form x Date	2	452570.0	3.27	3.32
Error A	33	138359.1		
Years	2	23258415.0	276.88	3.09
Years x Source	2	172400.0	2.05	3.09
Years x Form	2	33785.0	0.40	3.09
Years x Date	4	35847.5	0.43	2.46
Years x Source x Form	2	2543.0	0.30	3.09
Years x Source x Date	4	71227.5	0.85	2.46
Years x Form x Date	4	43987.5	0.52	2.46
Years x Source x Form x Date	4	145067.5	1.73	2.46
Years x Rep	6	276903.3	3.30	2.19
Error B	66	84002.1		
Total SS	143	464635.5		

VITA

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